

APPENDIX A: HYDRAULIC ANALYSES

Hydraulic tests were conducted on Amchitka Island by the United States Geological Survey (USGS) in the late 1960s and early 1970s to determine suitable zones for conducting nuclear tests and to characterize the hydrology of Amchitka Island. Most of the hydraulic tests were performed by either injecting (slug type) or swabbing (bail type) a known volume of water from the borehole followed by monitoring recovery of the fluid. Most of these tests were conducted in uncased boreholes using straddle packers to isolate specific zones. The length of the zones tested ranged from 18.3 to 485 m, with an average length of 85 m. Because of the high cost of rig time, these tests were only conducted for short periods of time, which often did not allow water to return to static conditions.

The USGS performed hydraulic tests in UAe-6H, UA-1, UA-1-HTH-1, UAe-7h, UAe-1, UAe-3, and UAe-2. The plots and analysis of these tests are reported in a series of publications released by the USGS (Ballance, 1970a, 1970b, 1972a, 1972b, 1972c, 1973b). The analysis of these data by the USGS produced results reported in relative specific capacities (RSC) as opposed to hydraulic conductivity or transmissivity (See Figure A1).

Because the groundwater modeling efforts on Amchitka Island required a description of the hydraulic conductivity with depth, the data presented in the USGS reports were reanalyzed using the method of Cooper et al. (1967). The analysis is conducted by plotting H/H_0 vs. time, where H is the head change in the well at time (t), and H_0 is the instantaneous head change in the well. To facilitate comparison of the measured data to the type curves provided by Cooper et al. (1967), head ratio is plotted on an arithmetic scale, while time is plotted on a logarithmic scale. The type curves are then laid over the data plots keeping the y axis coincident (i.e., the value of $H/H_0=1$ on both plots). The data are then matched to the type curve with a similar curvature by sliding the type curves along the x-axis. Once curve matching is complete, the transmissivity (T) can be calculated as

$$T = \frac{r_c^2}{t_1} \quad (1)$$

where t_1 is the time on the data plot where $\frac{Tt}{r_c^2} = 1.0$; r_c = radius of well casing; and t = time. The hydraulic conductivity is then determined by dividing the transmissivity by the length of the interval tested.

The following is an example of the calculation using the data presented in Figure A2. The diameter of the wells drilled on Amchitka Island were 0.062 m. Overlaying the type curves, Figure A3 on the data plot (Figure A2), t_1 was determined to be 11 minutes. Putting these values in Equation (1) the transmissivity is 0.1258 m²/day. Dividing by the length of the interval tested, 106 m, the hydraulic conductivity is 0.0012 m/day. Figure 4 shows the data plots used to determine hydraulic conductivity for the various tested intervals from the hydrologic test holes on Amchitka Island. Figure 5 through Figure 11 shows the lithologic logs and all of the intervals tested by the USGS on Amchitka Island.

While reviewing the work the USGS performed, several issues became apparent. In some of the hydraulic tests, leaks occurred around the inflatable packers making those tests invalid.

Swabbing test tended to give higher values for hydraulic conductivity, as it was suspected that injection of fluid tended to introduce fine material into the formation thus reducing the equilibration time and apparent hydraulic conductivity. Also tests were conducted for short time periods precluding full hydraulic equilibration.

REFERENCES

- Ballance, W.C., 1970a. Hydraulic testing of hole UAe-7h, Amchitka Island, Alaska. U.S. Geological Survey report USGS-474-84, 31p.
- Ballance, W.C., 1970b. Hydraulic tests in hole UA-1 and water inflow into an underground chamber, Amchitka Island, Alaska. U.S. Geological Survey report USGS-474-72, 54p.
- Ballance, W.C., 1972a. Hydraulic tests in drill hole UAe-1, Amchitka Island, Alaska. U.S. Geological Survey report USGS-474-102, 32p.
- Ballance, W.C., 1972b. Hydraulic tests in hole UAe-6h, Amchitka Island, Alaska. U.S. Geological Survey report USGS-474-104, 27p.
- Ballance, W.C., 1972c. Hydraulic testing of hole UA-1-HTH-1, Amchitka Island, Alaska. U.S. Geological Survey report USGS-474-144, 27p.
- Ballance, W.C., 1973a. Hydraulic tests in hole UAe-2, Amchitka Island, Alaska. U.S. Geological Survey report USGS-474-103.
- Ballance, W.C., 1973b. Hydraulic tests in hole UAe-3, Amchitka Island, Alaska. U.S. Geological Survey report USGS-474-26, Rev. 1, 30p.
- Cooper, H.J., J.D. Bredehoeft and I.S. Papadopoulos, 1967. Response of a finite-diameter well to an instantaneous charge of water. *Water Resources Research*, 3(1):263-269.

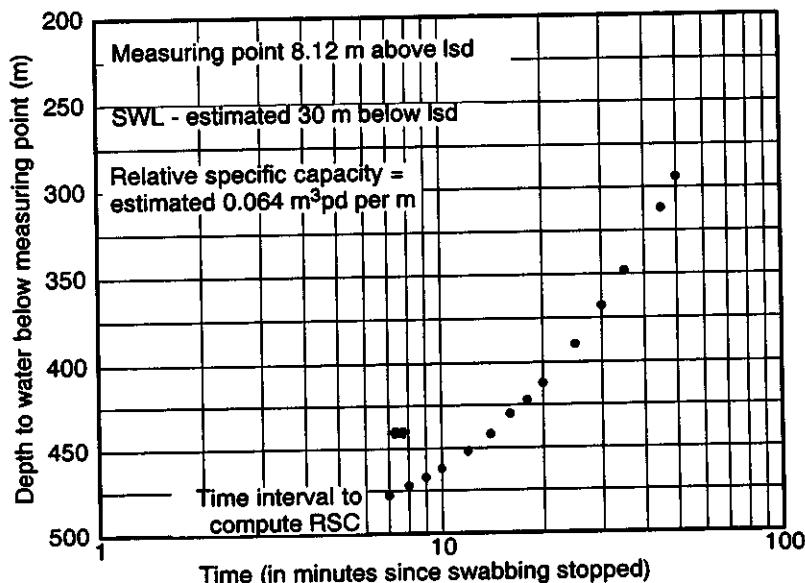


Figure A1. Swabbing recovery test from borehole UAe-2. Straddle packers were set to isolate the zone between 1,294.4 to 1,352.7 m.

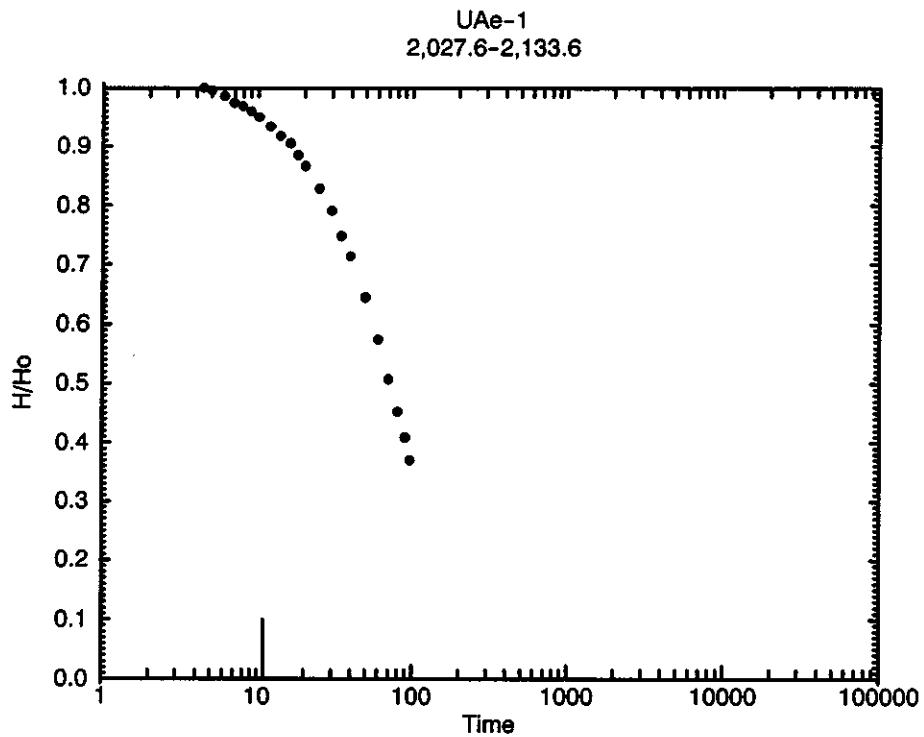


Figure A2. Plot of the ratio of measured head (H) to the head after injection or swabbing (H_0) with respect to time after injection or swabbing in minutes.

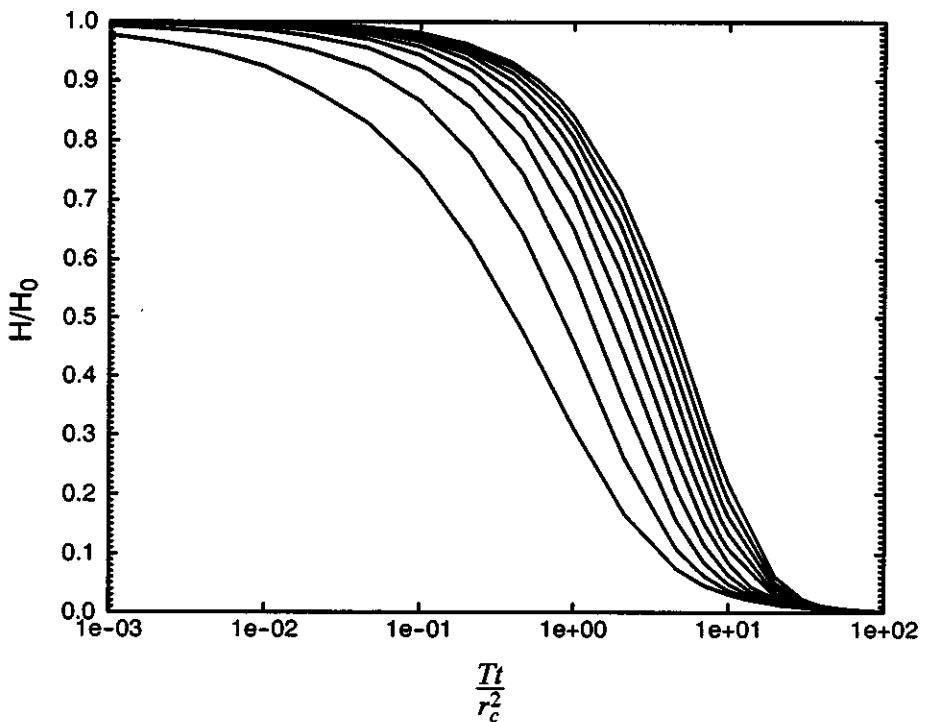


Figure A3. Type curves used in the analysis of data from Amichitka Island. H is the measured head above or below the static head, H_0 is the measured head above or below the static head immediately after injection or withdrawal, T is the transmissivity, t is the time in minutes and r_c is the radius of the well.

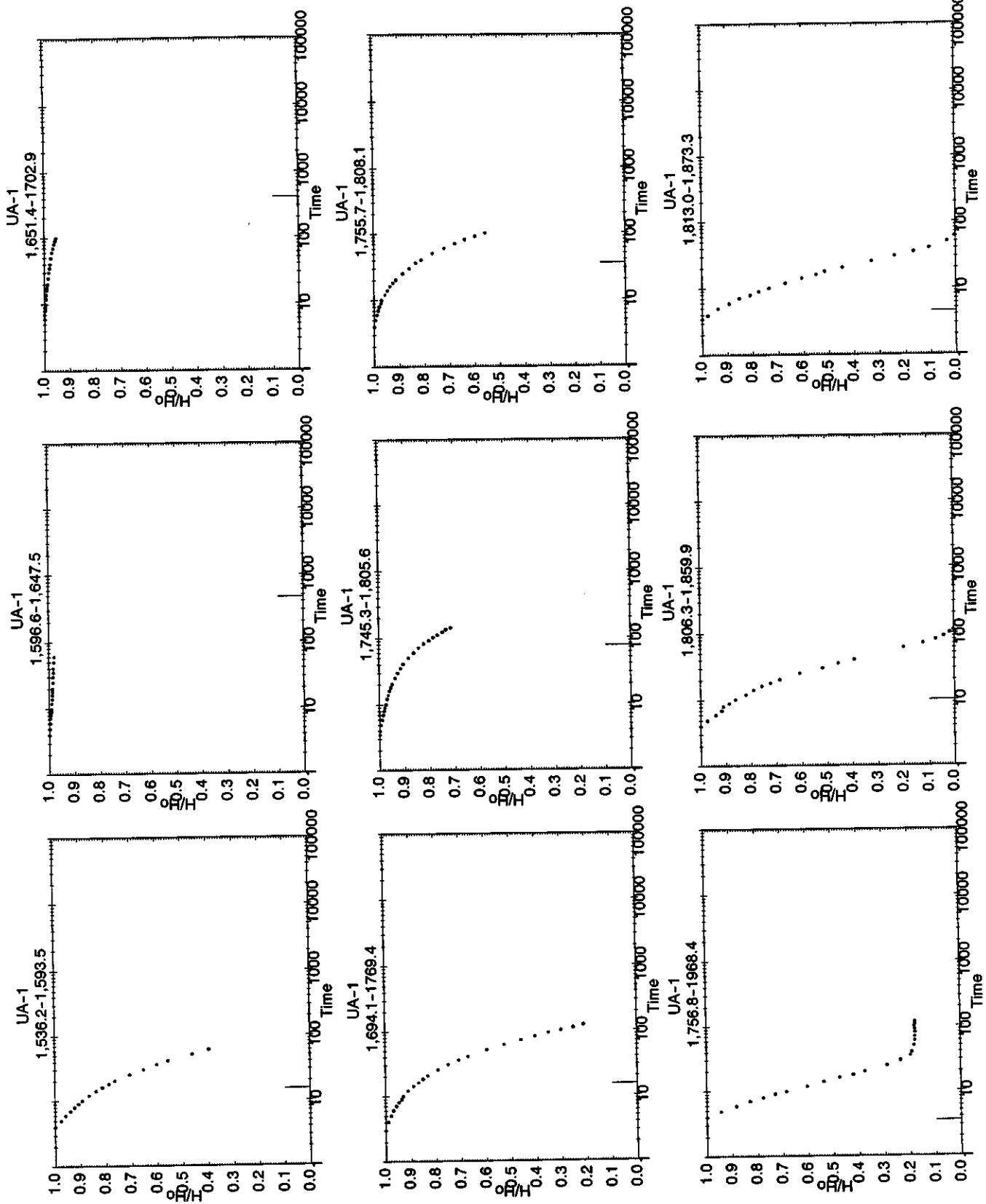


Figure A4. Data plots used to determine hydraulic conductivity from hydrologic test holes on Amchitka Island.

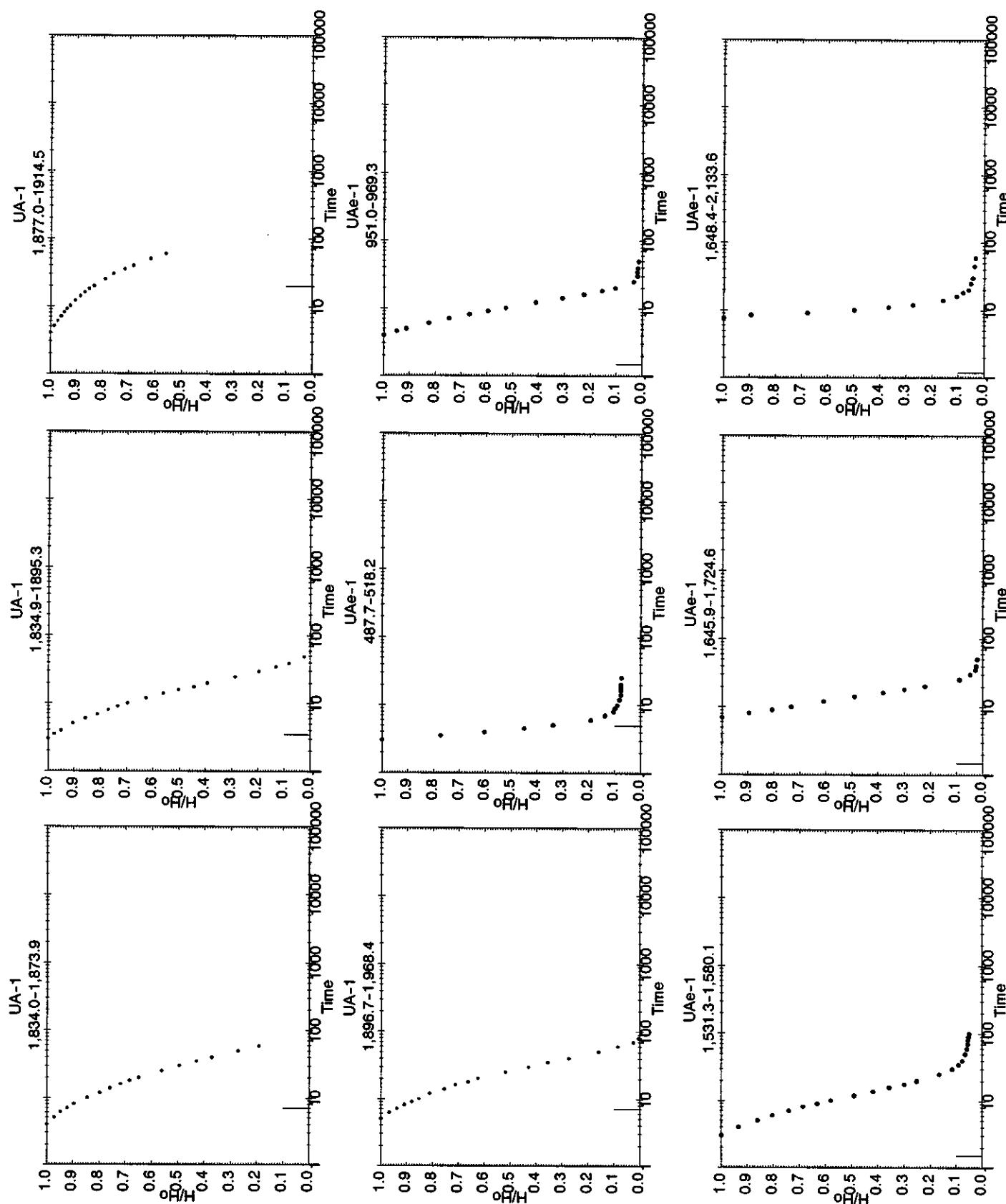


Figure A4. Data plots used to determine hydraulic conductivity from hydrologic test holes on Amchitka Island (continued).

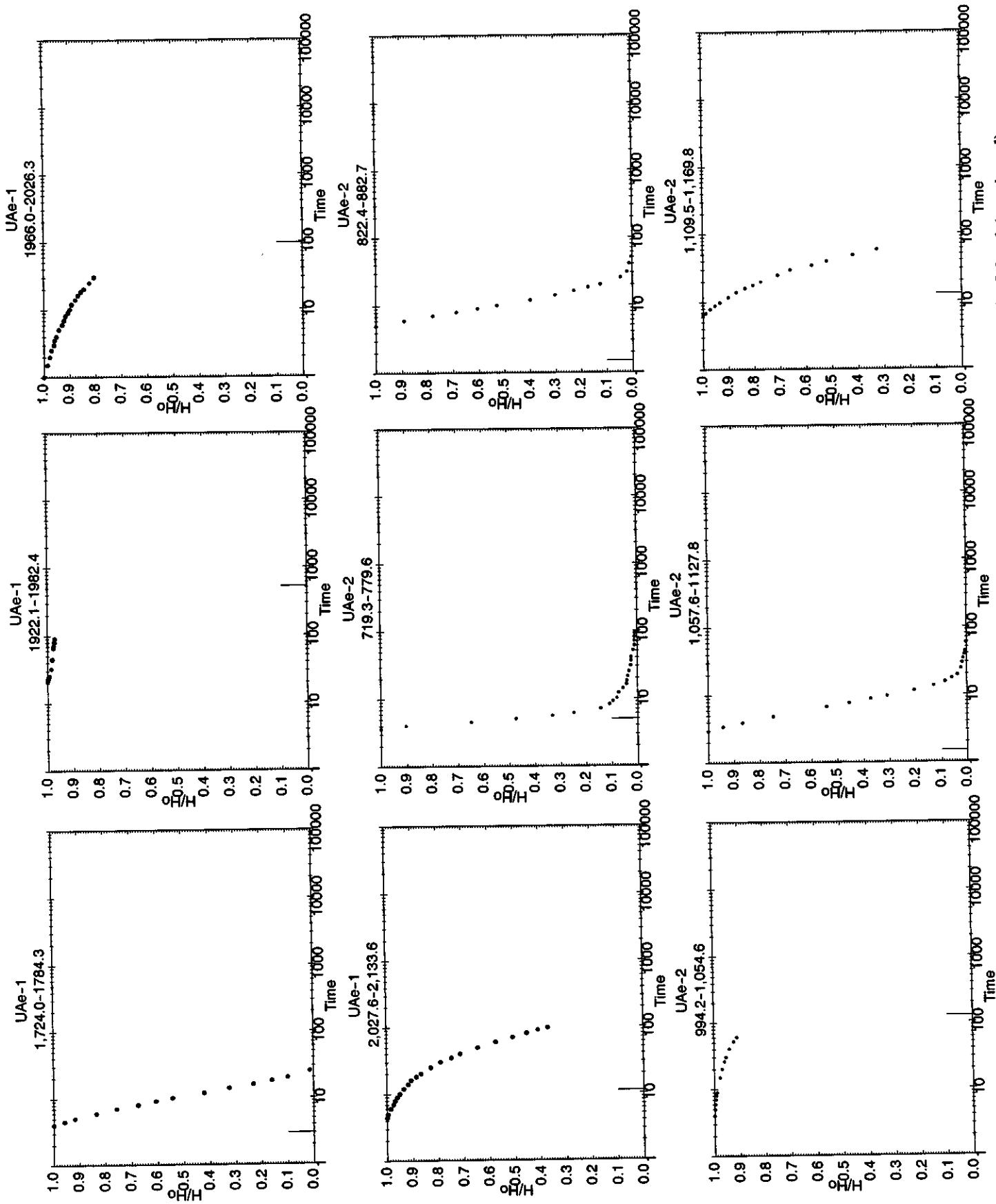


Figure A4. Data plots used to determine hydraulic conductivity from hydrologic test holes on Amchitka Island (continued).

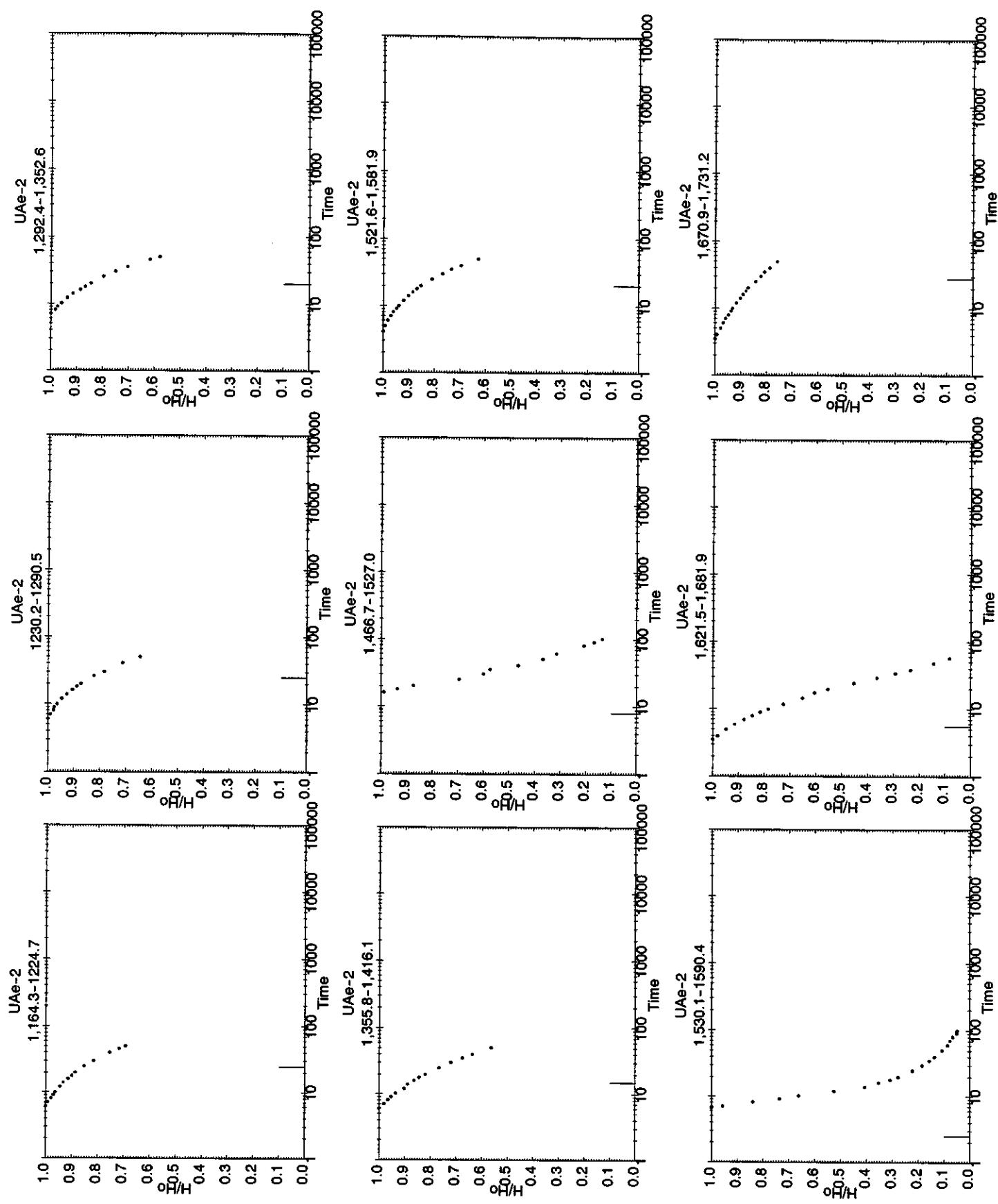


Figure A4. Data plots used to determine hydraulic conductivity from hydrologic test holes on Amchitka Island (continued).

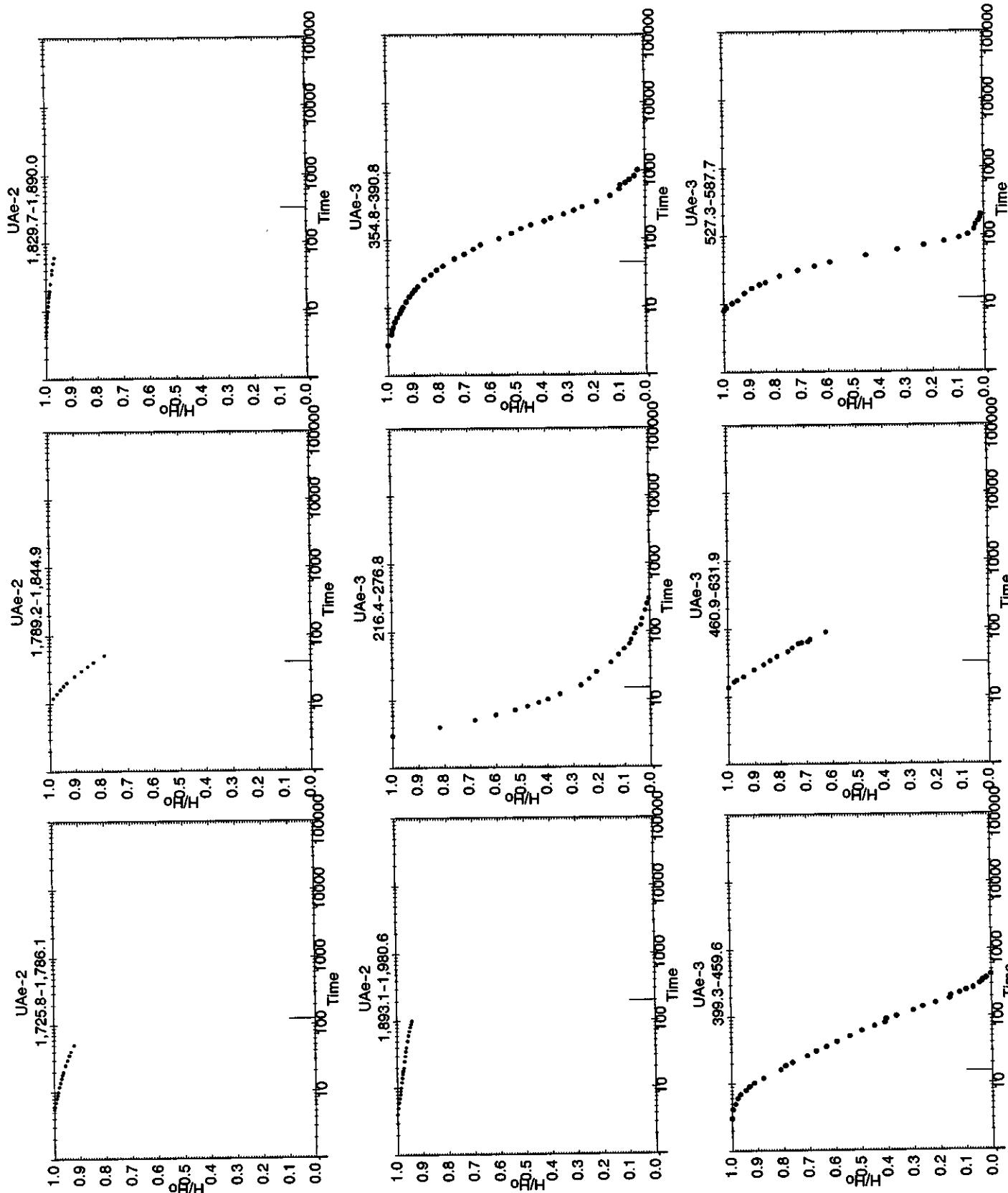


Figure A4. Data plots used to determine hydraulic conductivity from hydrologic test holes on Amchitka Island (continued).

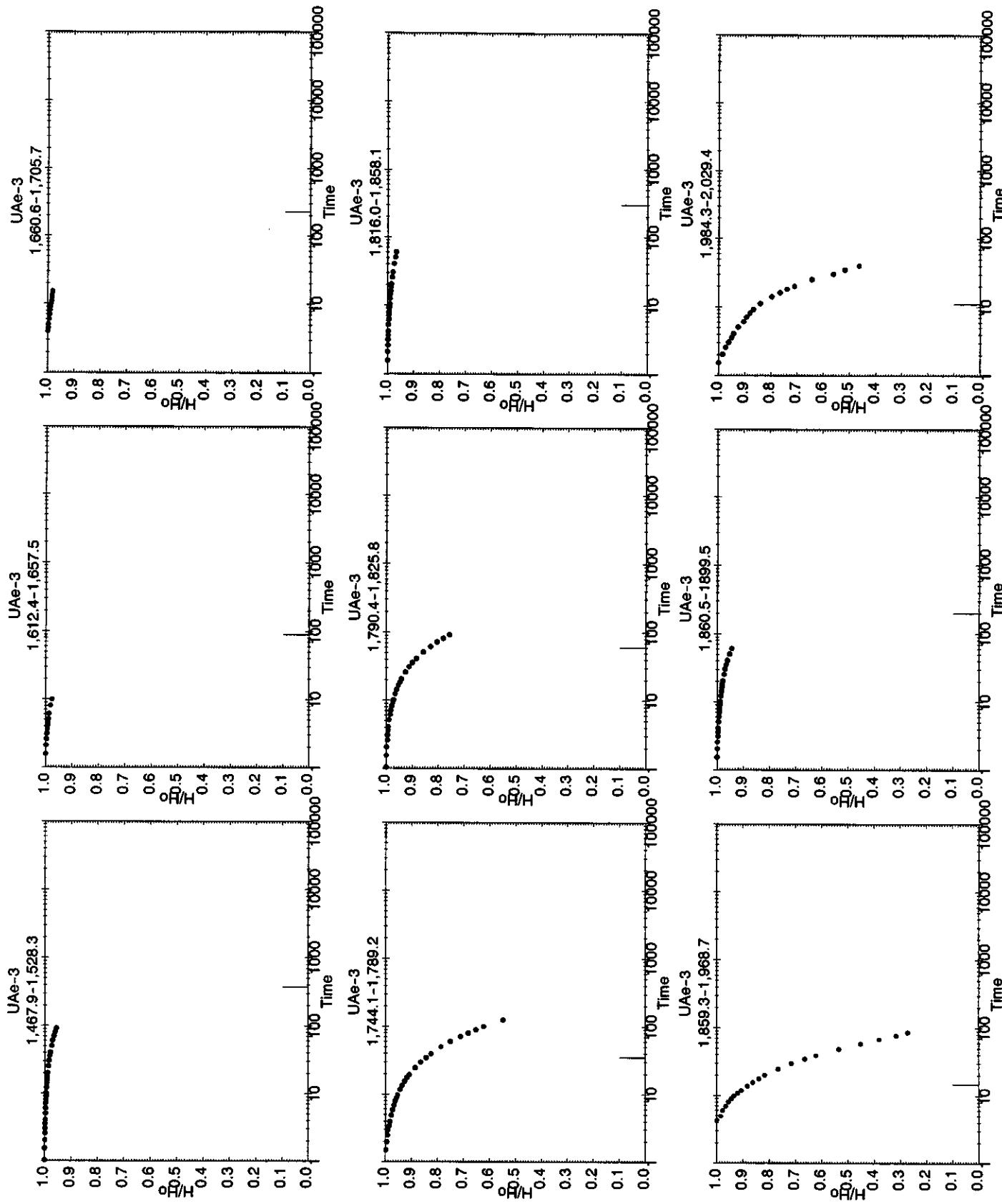


Figure A4. Data plots used to determine hydraulic conductivity from hydrologic test holes on Amchitka Island (continued).

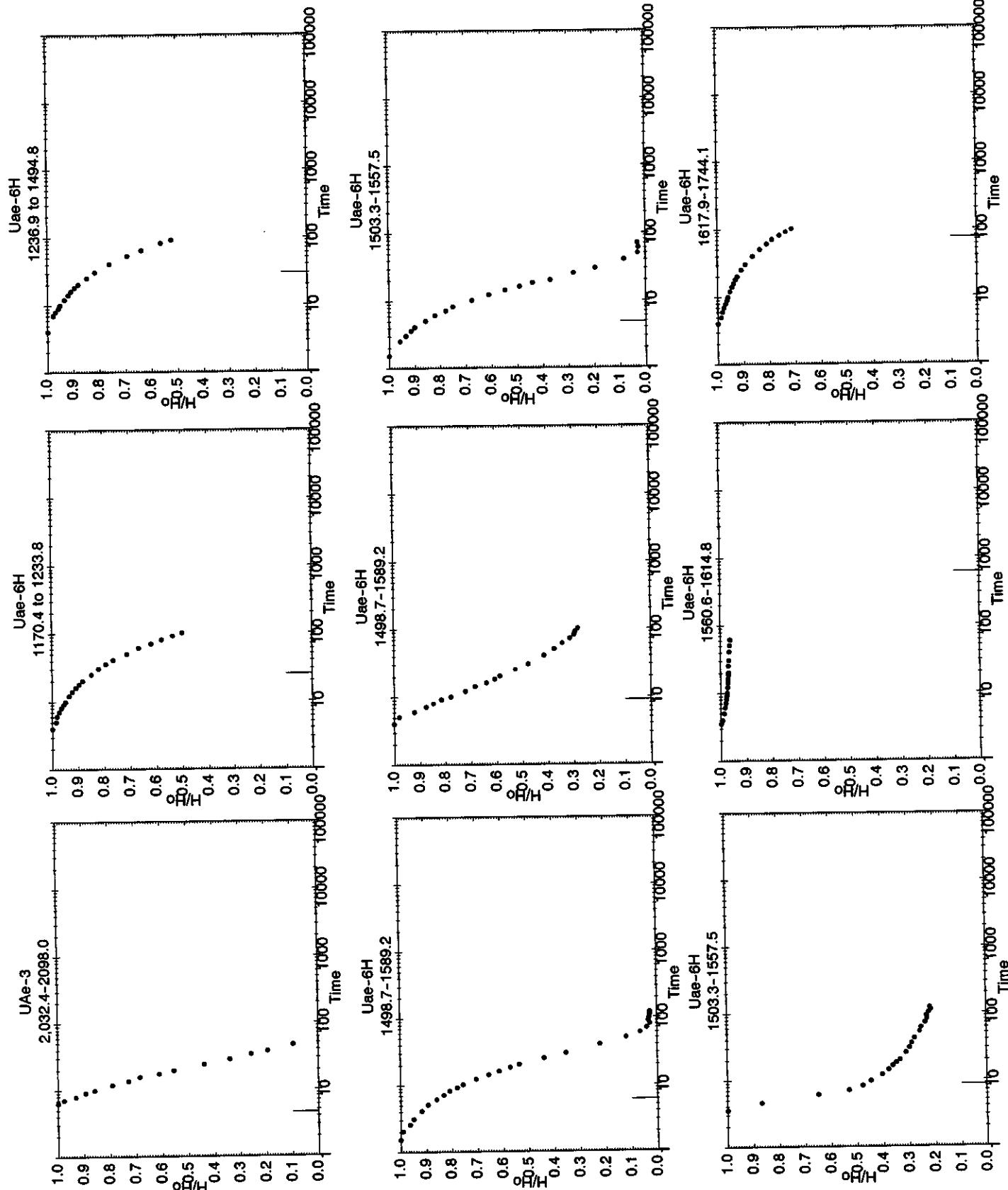


Figure A4. Data plots used to determine hydraulic conductivity from hydrologic test holes on Anchitka Island (continued).

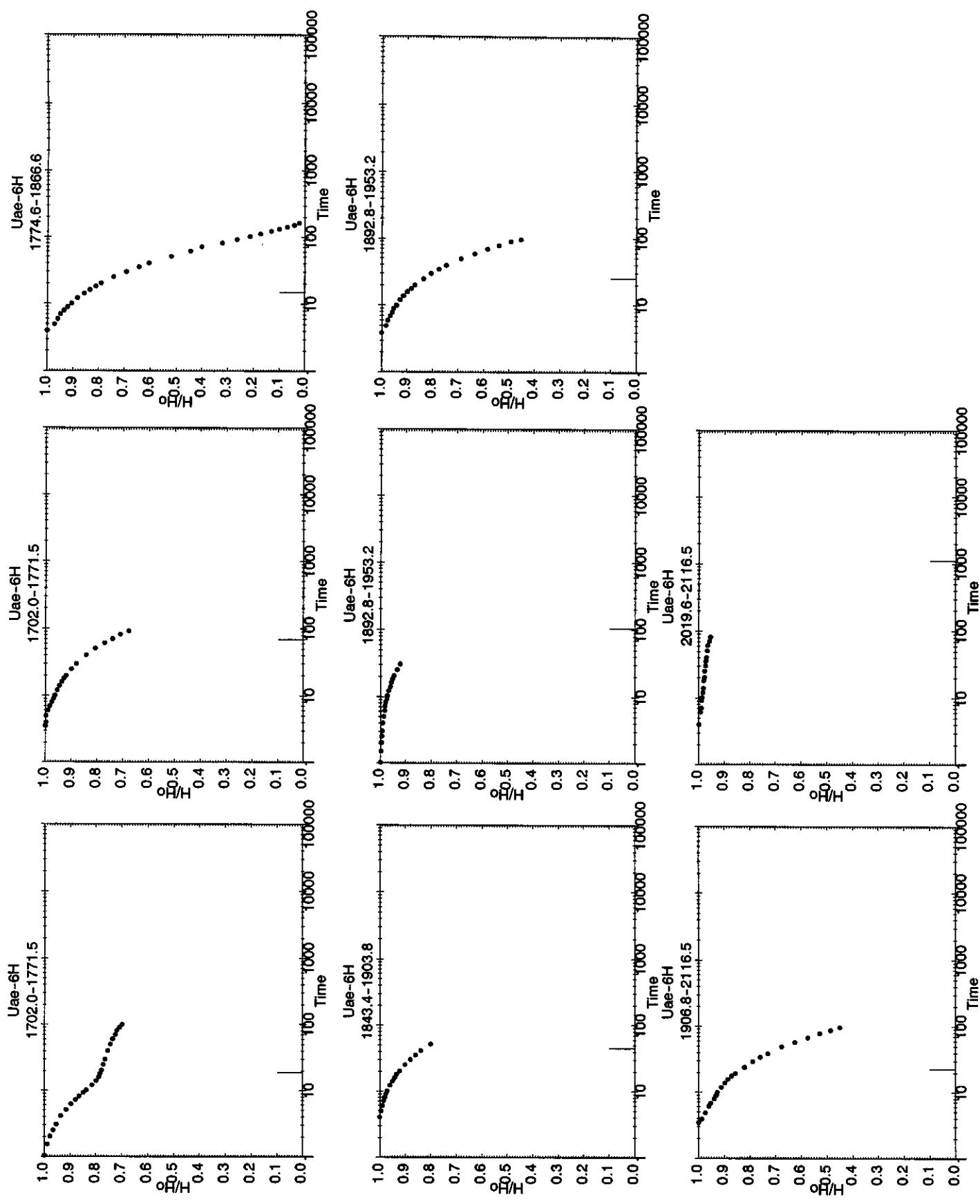
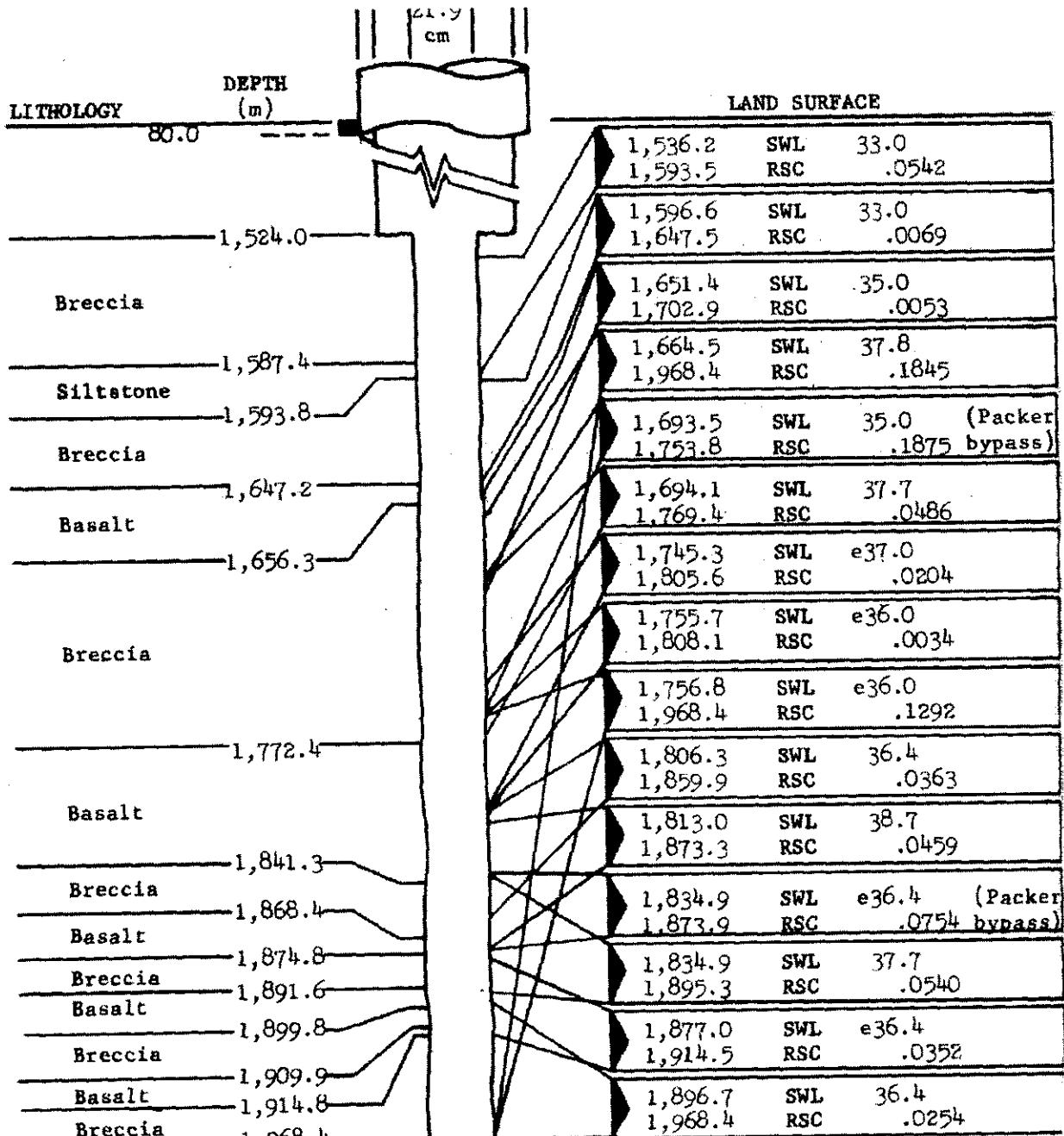


Figure A4. Data plots used to determine hydraulic conductivity from hydrologic test holes on Amchitka Island (continued).



[diagonal hatching] - Cement.

SWL - Static water level, meters below lsd

RSC - Relative specific capacity, $m^3 pd$ per m of drawdown

e - Estimated

Figure A5. Construction diagram, lithologic log and summary of hydrologic tests, hole UA-1 (after Balance, 1970b).

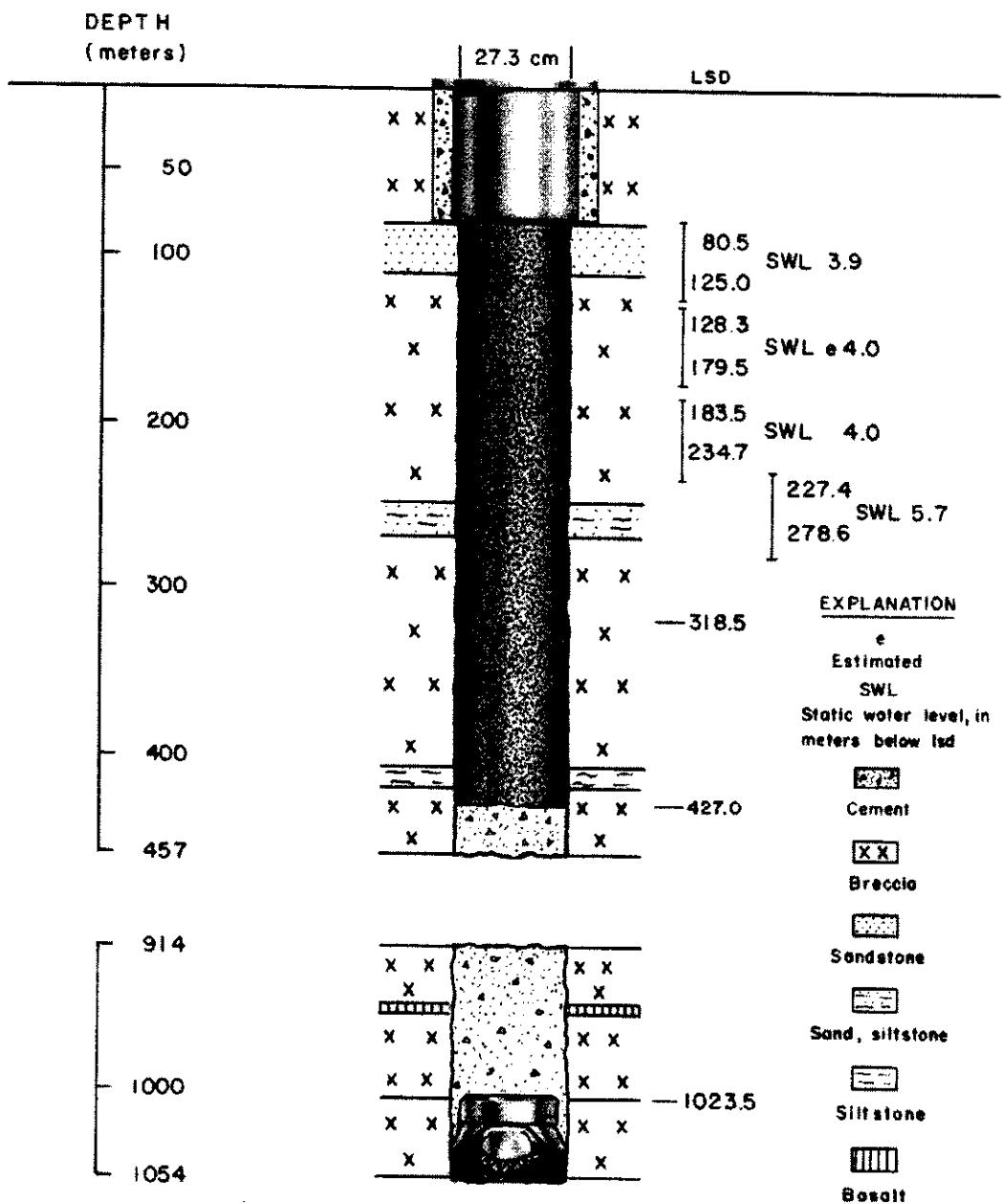


Figure A6. Construction diagram, lithologic log and summary of hydrologic tests, hole UA-1-HTH-1 (after Balance, 1972c).

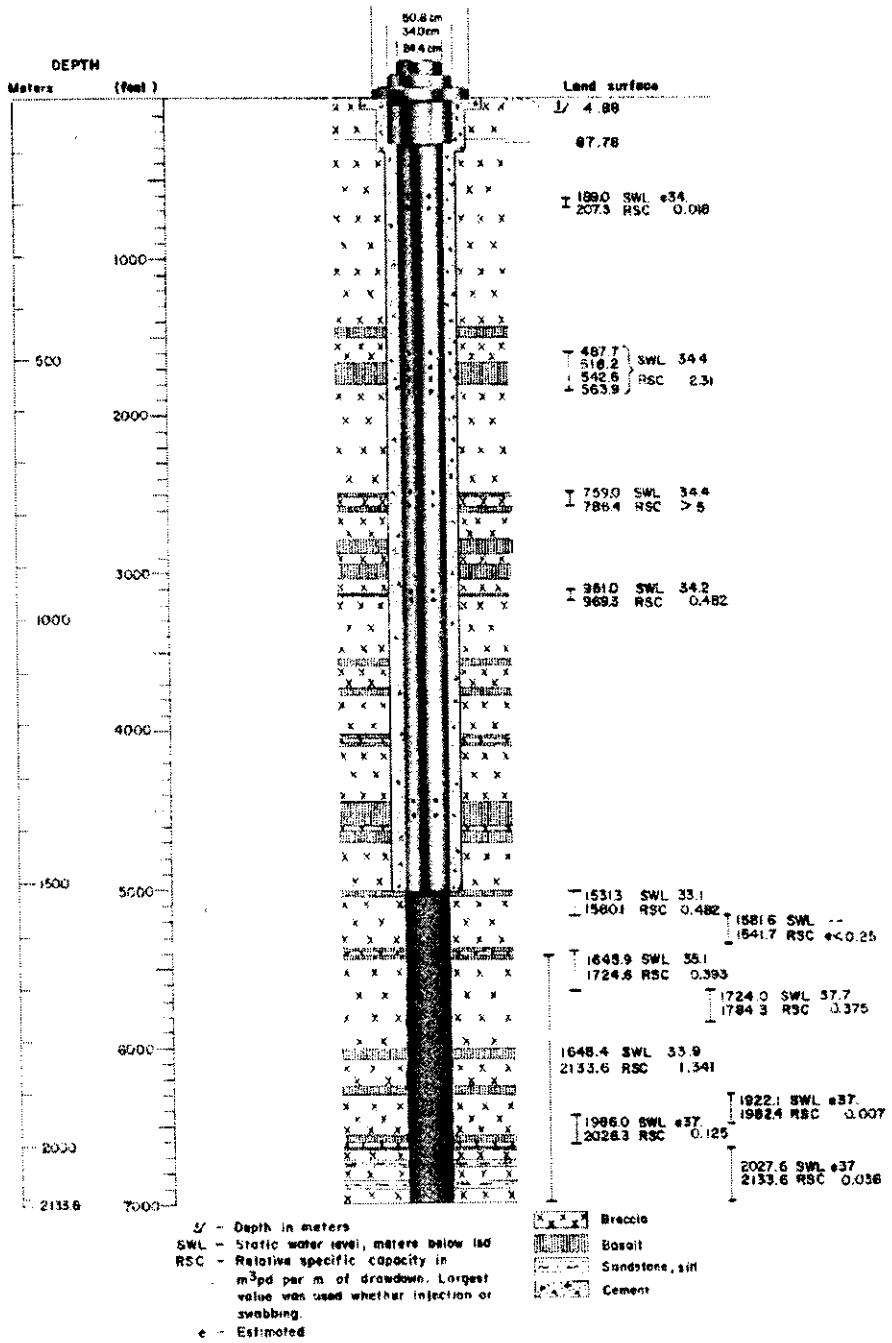


Figure A7. Construction diagram, lithologic log and summary of hydrologic tests, hole UAe-1 (after Balance, 1972a).

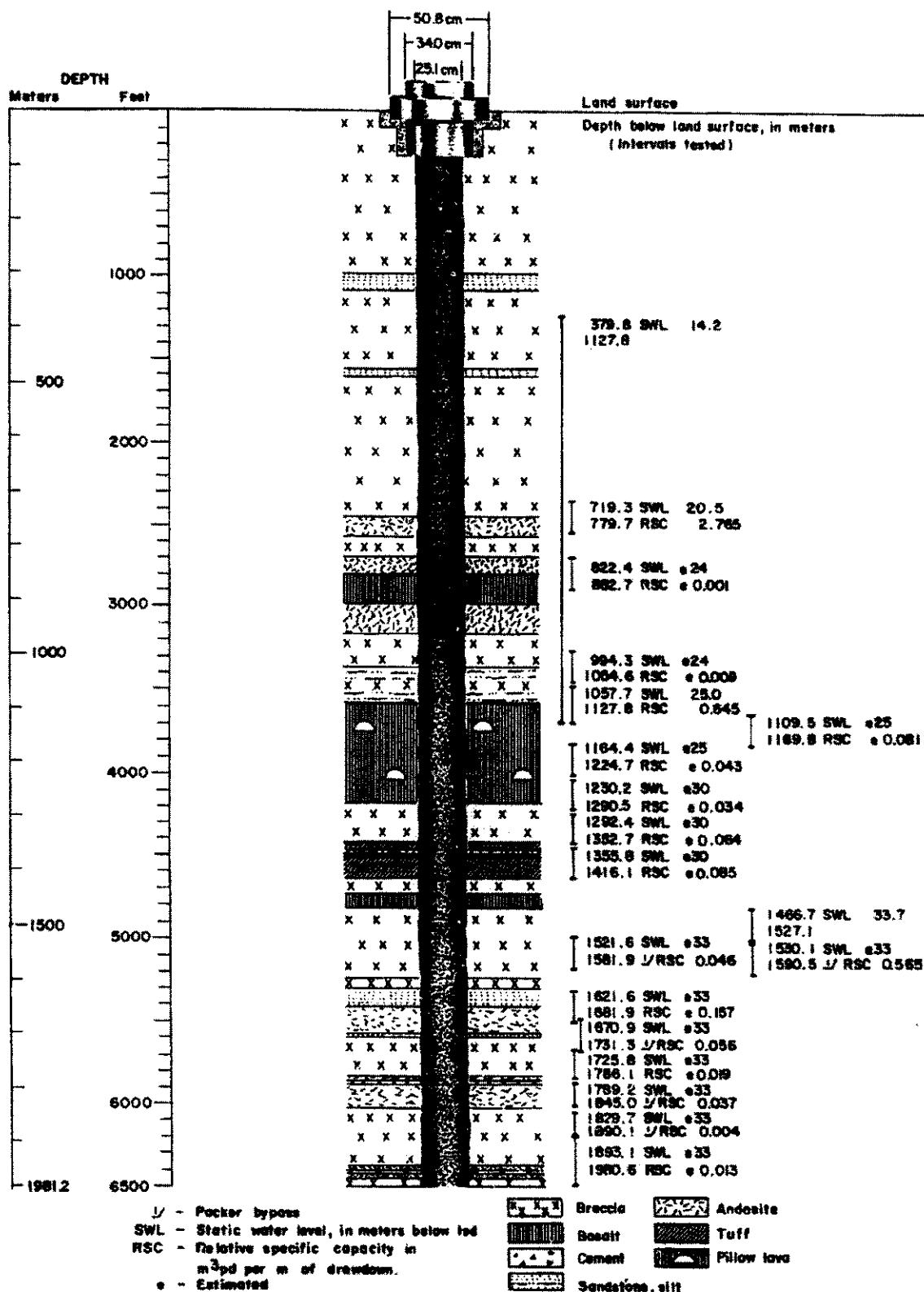


Figure A8. Construction diagram, lithologic log and summary of hydrologic tests, hole UAe-2 (after Balance, 1973a).

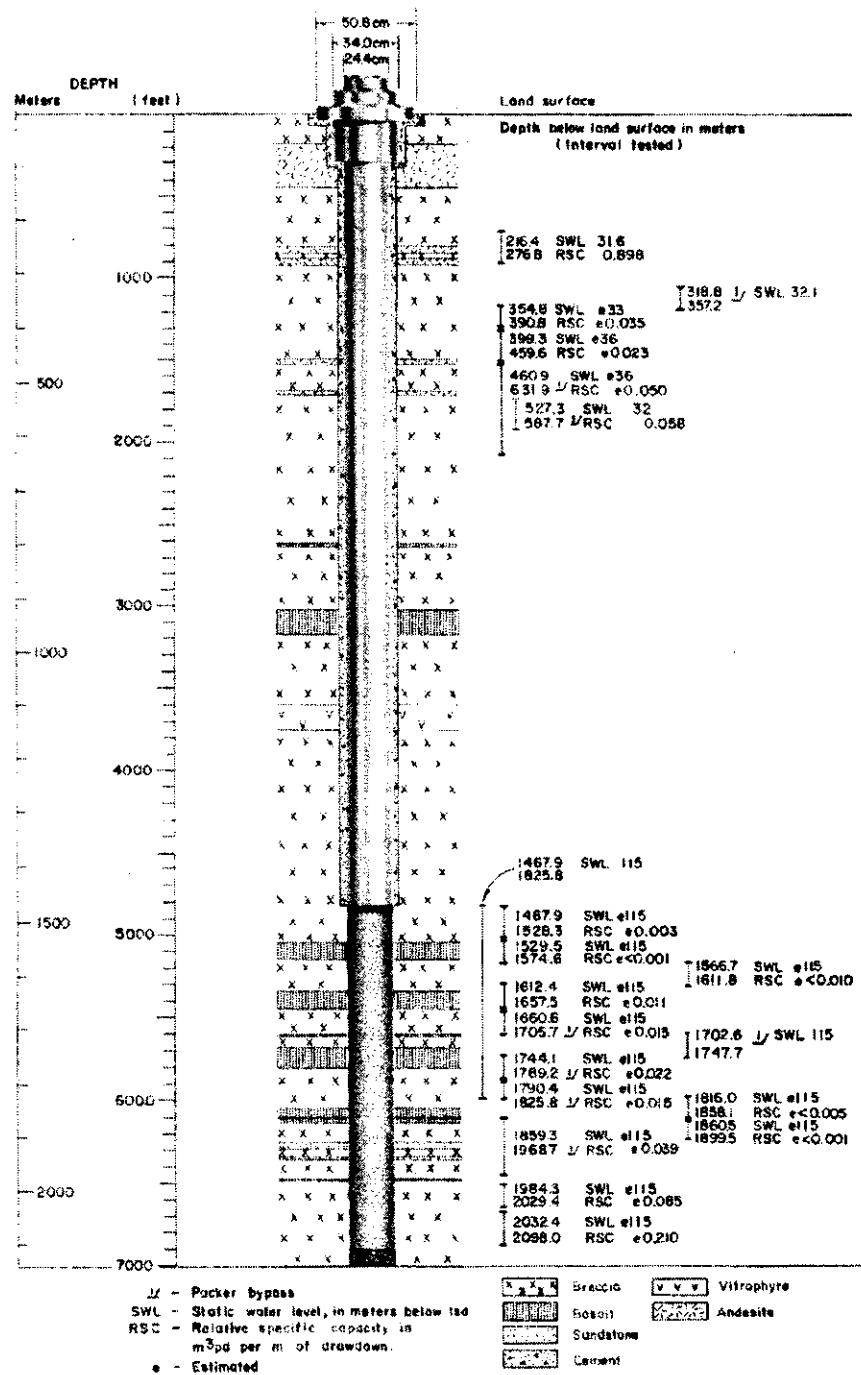


Figure A9. Construction diagram, lithologic log and summary of hydrologic tests, hole UAe-3 (after Balance, 1973b).

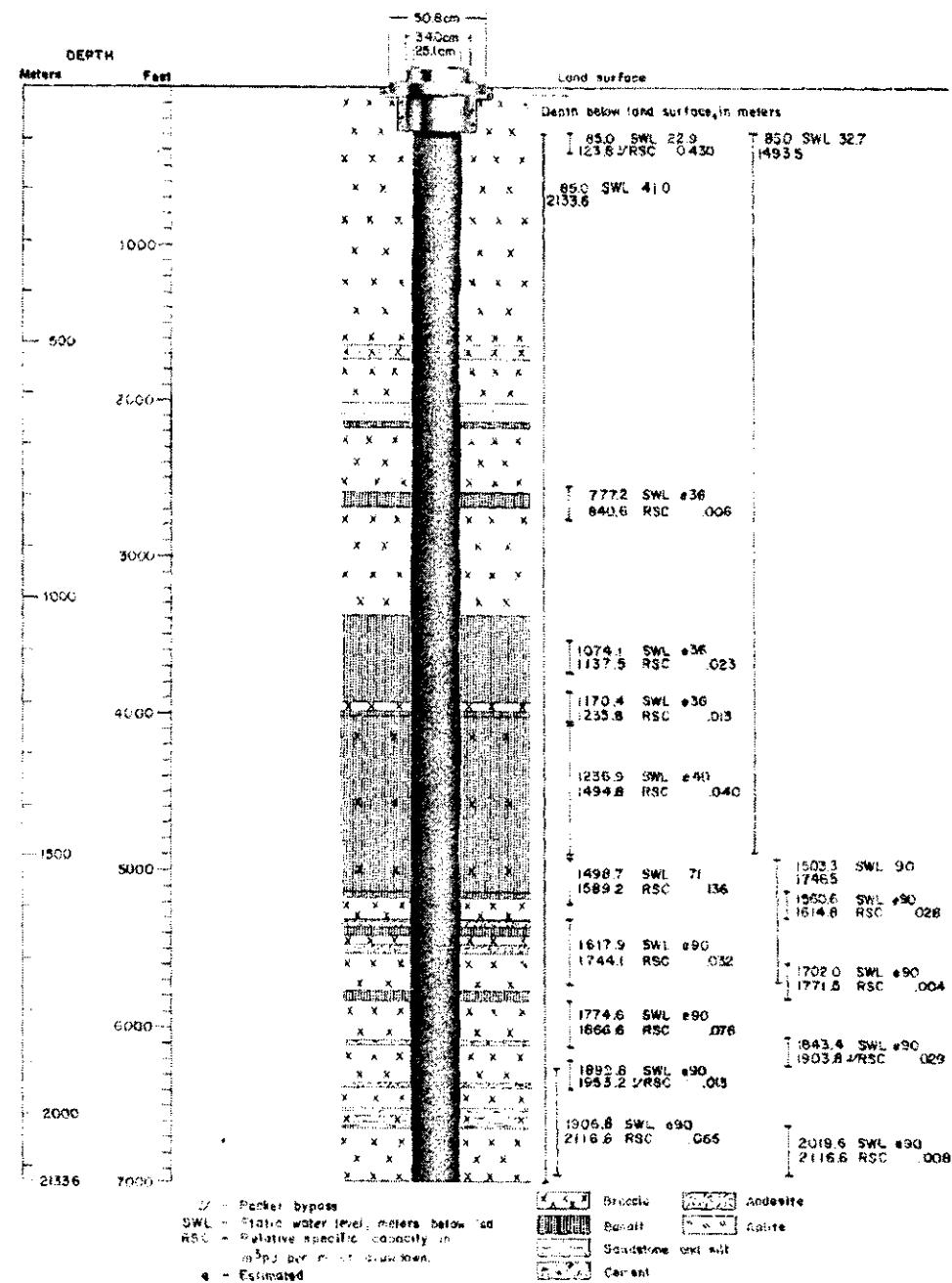


Figure A10. Construction diagram, lithologic log and summary of hydrologic tests, hole UAe-6h (after Balance, 1972b).

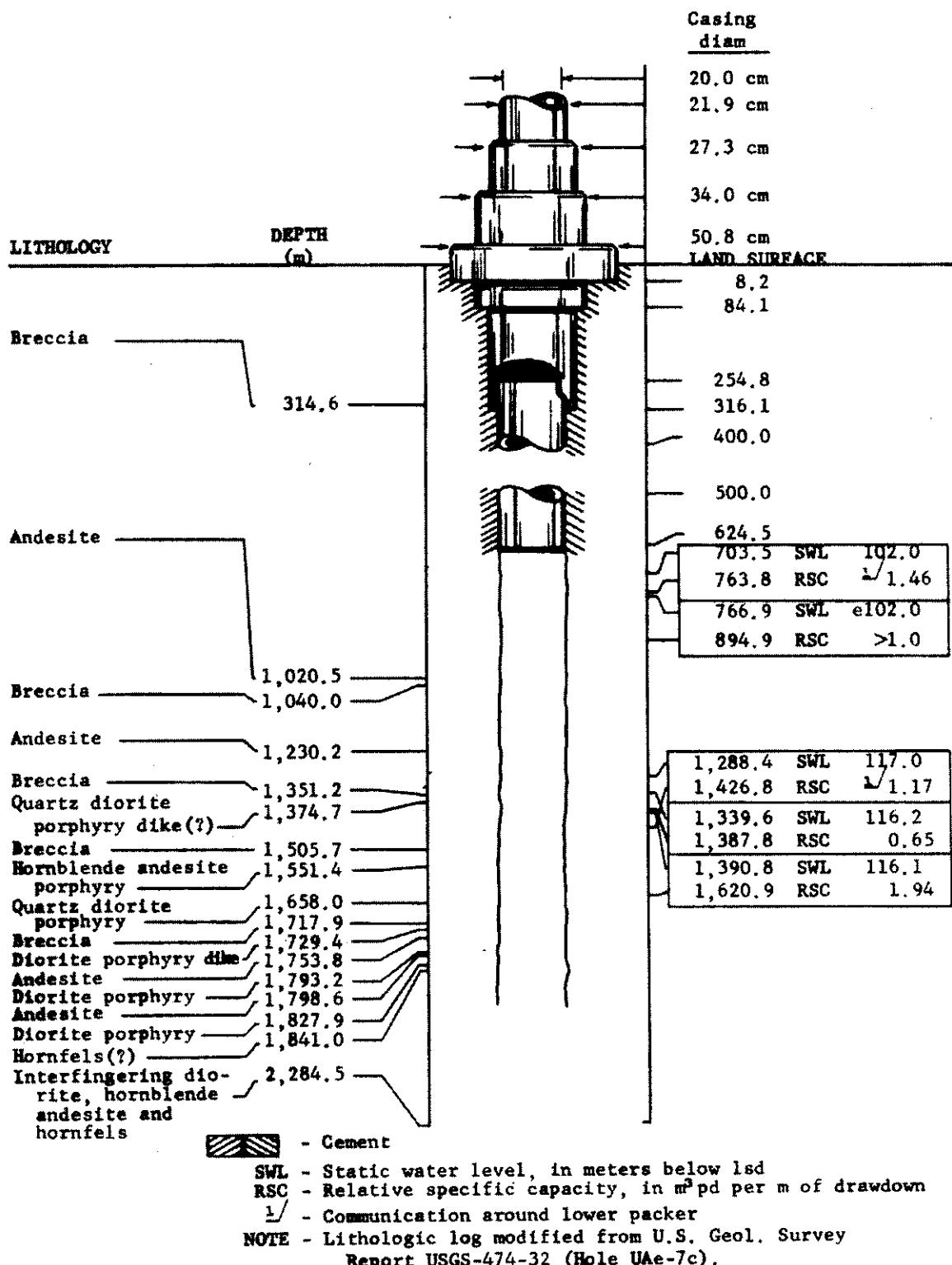


Figure A11. Construction diagram, lithologic log and summary of hydrologic tests, hole UAe-7h (after Balance, 1970a).